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(54) **MOBILE DEVICE-ACTIVATED VEHICLE FUNCTIONS**

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G06F 17/00 (2006.01)
B60R 25/24 (2013.01)

(52) **U.S. Cl.**

CPC ***G06F 17/00*** (2013.01); ***B60R 25/24*** (2013.01)

(58) **Field of Classification Search**

CPC G07C 5/008; B60R 25/24; F16H 2061/0081; F02N 11/0807; B60W 2050/0057
USPC 701/2, 36, 57; 340/5.2, 5.6, 5.61, 5.8
See application file for complete search history.

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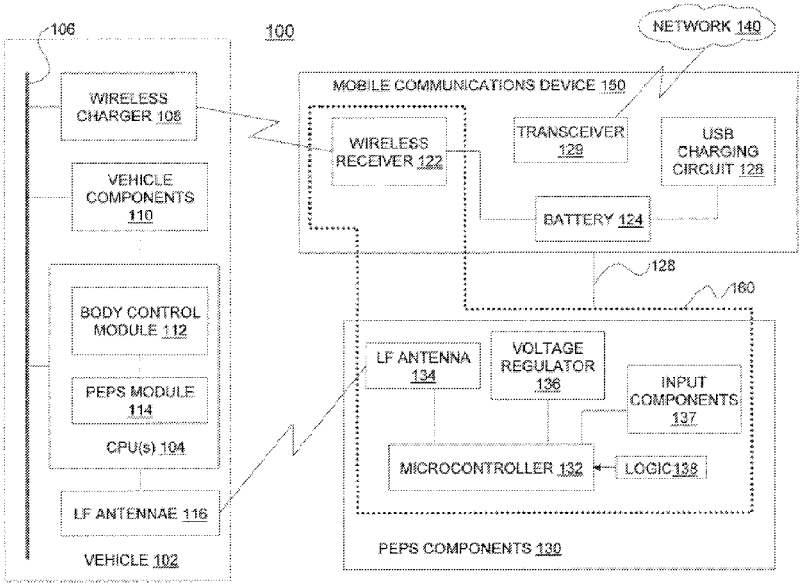
(57) **ABSTRACT**

Mobile device-activated vehicle functions are implemented by authenticating a vehicle with a device via wireless signals transmitted between a low frequency antenna of the device and a low frequency antenna of the vehicle when the vehicle is in communicative range of the device. The mobile device-activated vehicle functions are further implemented by receiving, via computer processor embedded in the device, a selection from one of a plurality of input components embedded in the device, the selection associated with a vehicle function, and transmitting a request to implement the vehicle function via the low frequency antenna coupled to the computer processor and the low frequency antenna of the vehicle.

14 Claims, 2 Drawing Sheets



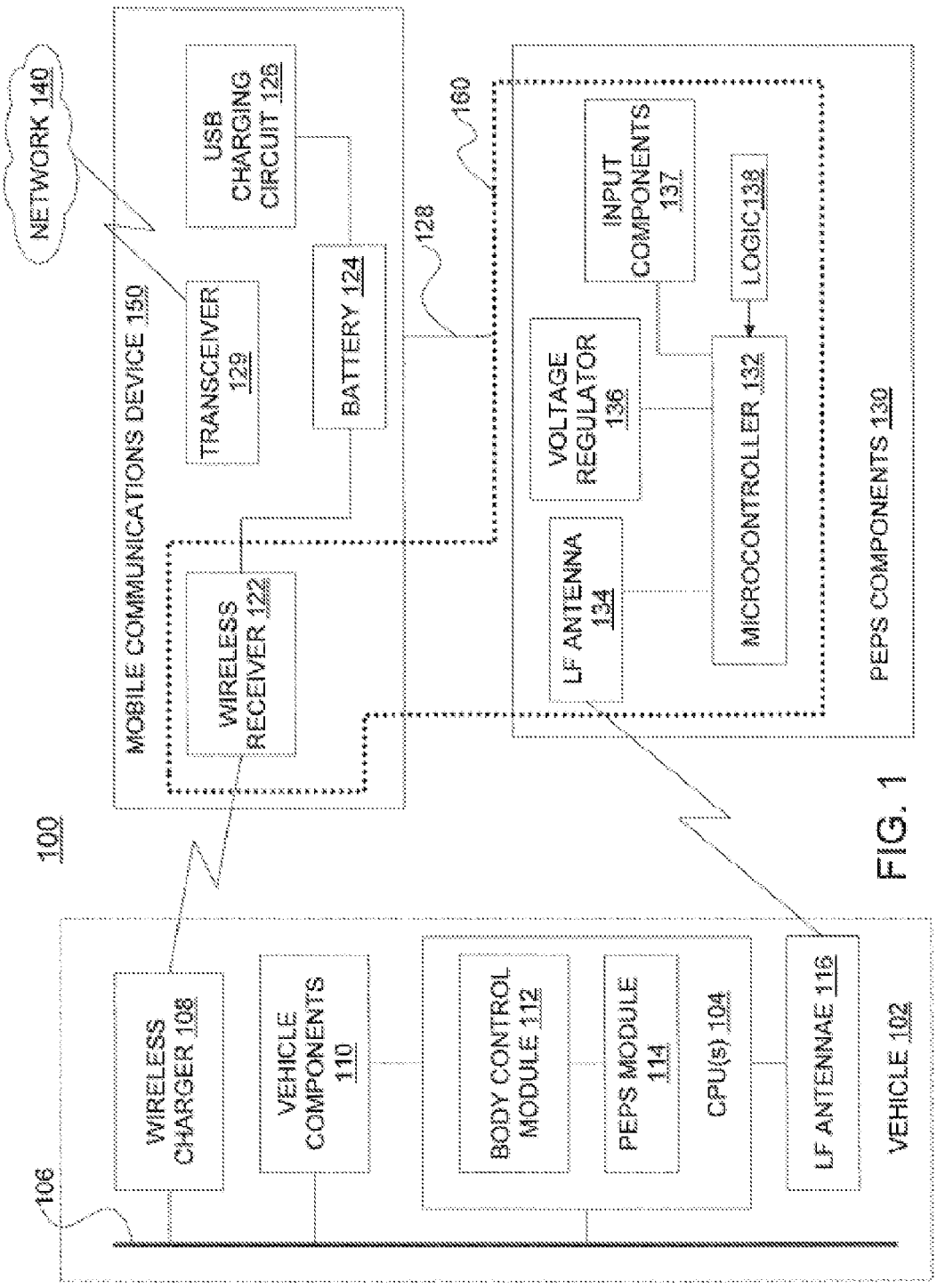

NETWORK 140
MOBILE COMMUNICATIONS DEVICE 150
USB CHARGING CIRCUIT 126
TRANSCEIVER 129
BATTERY 124
WIRELESS RECEIVER 122
128
160
INPUT COMPONENTS 137
LOGIC 138
VOLTAGE REGULATOR 136
MICROCONTROLLER 132
LF ANTENNA 134
PEPS COMPONENTS 130
100
106
WIRELESS CHARGER 108
VEHICLE COMPONENTS 110
BODY CONTROL MODULE 112
PEPS MODULE 114
CPU(s) 104
LF ANTENNAE 116
VEHICLE 102

FIG. 1

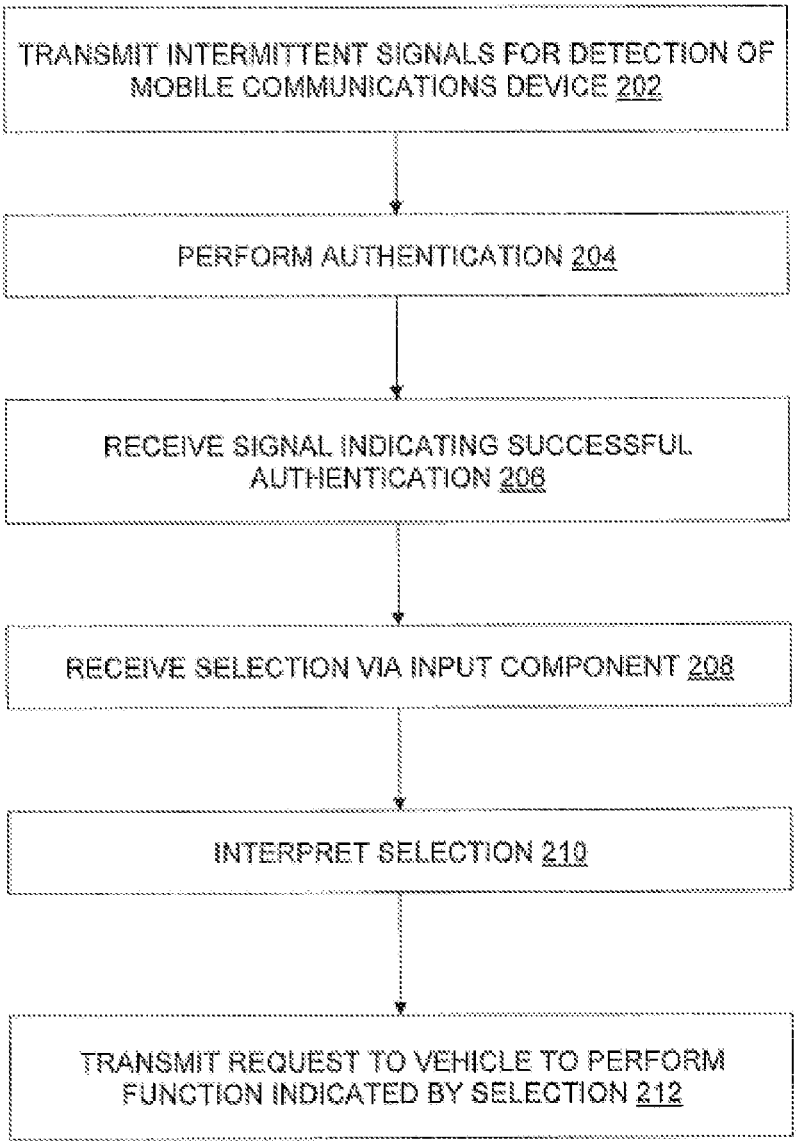

TRANSMIT INTERMITTENT SIGNALS FOR DETECTION OF MOBILE COMMUNICATIONS DEVICE 202
PERFORM AUTHENTICATION 204
RECEIVE SIGNAL INDICATING SUCCESSFUL AUTHENTICATION 206
RECEIVE SELECTION VIA INPUT COMPONENT 208
INTERPRET SELECTION 210
TRANSMIT REQUEST TO VEHICLE TO PERFORM FUNCTION INDICATED BY SELECTION 212

FIG. 2

MOBILE DEVICE-ACTIVATED VEHICLE FUNCTIONS

FIELD OF THE INVENTION

The subject invention relates to vehicle access and, more particularly, to mobile device-activated vehicle functions.

BACKGROUND

With the increased popularity of mobile communications devices, such as cellular telephones and smart phones, many individuals state they are more likely to forget their car keys and other electronic devices than they are to forget their mobile communications devices.

With the advent of wireless technology, many vehicle functions can now be implemented using a key fob that is programmed to perform remote functions with respect to the vehicle. However, keeping track of multiple key fobs and other electronic devices, such as mobile communications device and music players, etc., can be a difficult task.

Accordingly, it is desirable to provide a way to integrate features of various electronic devices to a single device.

SUMMARY OF THE INVENTION

In one exemplary embodiment of the invention a system is provided. The system includes a computer processor embedded in a device and input components embedded in the device. The input components are communicatively coupled to the computer processor. The system also includes a low frequency antenna communicatively coupled to the computer processor and logic executable by the computer processor. The logic is configured to implement a method. The method includes authenticating a vehicle with the device via wireless signals transmitted between the low frequency antenna and a low frequency antenna of the vehicle when the vehicle is in communicative range of the device. The method also includes receiving a selection from one of the input components. The selection is associated with a vehicle function. The method further includes transmitting a request to implement the vehicle function via the low frequency antenna coupled to the computer processor and the low frequency antenna of the vehicle.

In another exemplary embodiment of the invention, a method is provided. The method includes authenticating a vehicle with a device via wireless signals transmitted between a low frequency antenna of the device and a low frequency antenna of the vehicle when the vehicle is in communicative range of the device. The method also includes receiving, via computer processor embedded in the device, a selection from one of a plurality of input components embedded in the device. The selection is associated with a vehicle function. The method further includes transmitting a request to implement the vehicle function via the low frequency antenna coupled to the computer processor and the low frequency antenna of the vehicle.

In yet another exemplary embodiment of the invention, a computer program product is provided. The computer program product includes a storage medium embedded with computer instructions, which when executed by a computer processor embedded in a device, causes the computer processor to implement a method. The method includes authenticating a vehicle with the device via wireless signals transmitted between a low frequency antenna of the device and a low frequency antenna of the vehicle when the vehicle is in communicative range of the device. The method also includes receiving a selection from one of a plurality of input components embedded in the device. The selection is associated with a vehicle function. The method further includes transmitting a request to implement the vehicle function via the low frequency antenna coupled to the computer processor and the low frequency antenna of the vehicle.

The above features and advantages and other features and advantages of the invention are readily apparent from the following detailed description of the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features, advantages and details appear, by way of example only, in the following detailed description of embodiments, the detailed description referring to the drawings in which:

FIG. **1** is a block diagram of a system upon which vehicle functions and communications via a mobile communications device may be implemented in an embodiment; and

FIG. **2** is a flow diagram of a process for implementing vehicle functions and communications via a mobile communications device in an embodiment.

DESCRIPTION OF THE EMBODIMENTS

The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses.

In accordance with an exemplary embodiment of the invention, vehicle functions and communications are provided. The vehicle functions and communications enable a user of a mobile communications device to implement various vehicle functions, such as authentication, passive entry passive start (PEPS), wireless charging of the mobile communications device in the vehicle, and the tracking of location data. The mobile communications device is equipped with a peripheral device, such as a case or sleeve that has embedded circuitry for implementing the vehicle functions and communications described herein. While the vehicle functions and communications are described herein with respect to a peripheral device that is comprised of a case or a sleeve, it will be understood that other means of implementing the vehicle functions and communications may be employed. For example, a mini or micro secure digital (SD) card or memory device embedded in the mobile communications device may be programmed to implement the exemplary functions described herein.

The system **100** of FIG. **1** includes a portion of a vehicle **102** and a mobile communications device **150**. The vehicle **102** may be any type of automobile, truck, utility vehicle, van, etc., known in the art. The mobile communications device **150** may be a cellular telephone or smart phone. The mobile communications device **150** may be owned or operated by an occupant or operator of the vehicle **102**.

The vehicle **102** includes one or more computer processing units (CPUs) **104**, a wireless charger **108**, and vehicle components **110**, each of which is communicatively coupled to a network bus **106**.

The CPUs **104** are implemented in hardware, such as processor cores, registers, caches, decoders, and instruction execution units, to name a few. The CPUs **104** may form part of the vehicle's **102** central control system.

The wireless charger **108** includes a magnetic inductive charging unit (e.g., Powermat®) that is coupled to the vehicle's bus **106** or may include its own power source. The

wireless charger **108** wirelessly transmits electrical power to the mobile communications device **150**, as will be described further herein.

The vehicle components **110** may include any systems, devices, or elements of the vehicle **102** under the operational control of the CPUs **104**. Non-limiting examples of the vehicle components **110** include a vehicle ignition, power locks, power windows, power mirrors, and vehicle lighting.

The network bus **106** may be implemented as a wireline network or wireless network. In one embodiment, the network bus **106** is implemented as a serial data bus that forms part of a local area network of the vehicle **102**.

The CPU(s) **104** execute a body control module (BCM) **112** and a passive entry passive start (PEPS) module **114** for managing the operation of the components **110**, such as remote lock and unlock, remote start, power windows and mirrors, power locks, and lighting systems. The BCM **112** and PEPS module **114** may be implemented as logic that is stored in a memory location of the vehicle **102** and executed by the CPU(s) **104** as described further herein.

The vehicle **102** also includes low frequency (LF) antennae **116** that are dispersed around the interior and/or exterior portions of the vehicle **102**. The low frequency antenna **116** may be radio frequency antenna configured to communicate wirelessly using a pre-defined communication protocol, such as Bluetooth™ or other communication protocol, such as WiFi. The low frequency antennae **116** receive and transmit communications to the mobile communications device **150**, which communications are facilitated via the body control module **112** and the PEPS module **114**. These communications include authentication of external devices, such as the mobile communications device **150**, PEPS functions, and other information as described further herein.

In an embodiment, the mobile communications device **150** includes a wireless receiver **122**, a battery **124**, a universal serial bus (USB) charging circuit **126**, and a transceiver **129**. The wireless receiver **122** and the USB charging circuit **126** may each be coupled to the battery **124** via discrete wiring.

The wireless receiver **122** may be built into the mobile communications device **150** during the manufacturing process or may be fitted with the mobile communications device **150** as an aftermarket feature. For example, the wireless receiver **122** may be built into a sleeve or case **160** that couples with the mobile communications device **150** when the mobile communications device **150** is placed in the sleeve or case **160**.

The battery **124** may be a standard lithium ion battery configured for use in cellphones and smart phones. The USB charging circuit **126** may include a built in port and circuitry in the mobile communications device **150** for receiving a USB cable that is coupled to an external power source. Thus, the battery **124** may be charged wirelessly through the wireless receiver **122** or through a wired connection via the USB charging circuit **126**. The transceiver **129** includes communication components for enabling the mobile communications device **150** to communicate over one or more networks. As shown in FIG. **1**, the mobile communications device **150** is communicatively coupled to a network **140** via the transceiver **129**. A user of the mobile communications device **150** initiates and receives communications over the network **140**, which may be a cellular network.

Also shown in FIG. **1** are PEPS components **130**. The PEPS components **130** include a microcontroller **132**, a low frequency antenna **134**, a voltage regulator **136**, input components **137**, and logic **138**. The microcontroller **132** may be implemented on an integrated circuit that includes a processor core, memory, and programmable input/output elements. The microcontroller **132** executes the logic **138** for implementing various features and functions described herein.

The low frequency antenna **134** may be a radio frequency antenna configured to communicate wirelessly using a predefined communication protocol, such as Bluetooth™. In an embodiment, the low frequency antenna **134** communicates with the low frequency antennae **116** in order to authenticate the mobile communications device **150** with the vehicle **102** and enable the mobile communications device **150**, once authenticated, to direct various vehicle functions, such as PEPS functions.

The voltage regulator **136** stabilizes the voltage used by the microcontroller **132** and other elements of the mobile communications device **150**. In an embodiment, the voltage regulator **136** cuts off power to the PEPs components **130** once the battery **124** has reached critical levels to reduce the incidence of battery drain that may otherwise occur.

The input components **137** may be buttons or other elements that are coupled to the microcontroller **132** and receive input selections from a user of the mobile communications device **150**, which input selections are configured to direct the microcontroller **132** to perform a designated function.

The PEPS components **130** may be built into the mobile communications device **150** during manufacture or may be provided as an aftermarket event. For example, the PEPS components **130** may be embedded in a sleeve or case that couples with the mobile communications device **150** when the mobile communications device **150** is placed in the sleeve. As shown in FIG. **1** for purposes of illustration, the PEPS components **130** are embedded in the sleeve or case **160**. The sleeve or case **160** may be communicatively coupled to the mobile communications device via a cable or wiring **128** (e.g., a serial data bus or optical connection) or may be a wireless connection implemented through a wireless node (e.g., via near field communications (NFC) technology).

In operation, when an individual approaches the vehicle **102** with the mobile communications device **150**, the LF antennae **116** within range of the mobile communications device **150** enables the device **150** to authenticate itself to the PEPS module **114** via a wireless signal. Upon successful authentication, the PEPS module **114**, in cooperation with the BCM **112** performs the appropriate PEPS function (e.g., remote lock and unlock, remote start, power door activation, power tailgate/decklid activation, panic, and other functions that might be triggered using the mobile communications device **150**). In an embodiment, a user selects an input component **137** that is associated with a particular PEPS function (e.g., unlock door) and the microcontroller **132** transmits a request to the PEPS module **114** via the respective LF antennae **134** and **116**. The PEPS module **114**, in turn, directs the BCM **112** to transmit a corresponding signal over the bus **106** to the appropriate vehicle component **110**.

In another embodiment, authentication of the device **150** may be initiated when the device **150** is placed on the wireless charger **108**. In this embodiment, a power charging status of the wireless charger **108**, which is indicative of the device's **150** presence on the wireless charger **108**, is used to begin the authentication process. Additionally, other functions may be implemented using the power charging status, such as automatic activation of the vehicle (e.g., ignition on), door locking, and transfer of content from the mobile communications device **150** (e.g., music, contacts, destinations/routes, updates to vehicle telematics system, etc.) to the vehicle.

Additionally, the wireless receiver **122** of the mobile communications device **150** (either embedded therein, or communicatively coupled thereto via the sleeve or case **160**) enables

the battery **124** of the mobile communications device **150** to be wirelessly charged when in contact with the wireless charger **108**.

In an embodiment, the logic **138** of the PEPS components **130** may be configured to revoke or suspend use of the vehicle functions and communications described herein in response to instructions received over the network **140** (e.g., from the cellular telephone service provider when the customer notifies the provider that his/her cellular telephone is lost).

Turning now to FIG. **2**, a process for implementing the vehicle functions and communications will now be described in an embodiment. The process described in FIG. **2** assumes that a user of the mobile communications device **150** has entered an area that is in communicative range of the vehicle **102**.

At step **202**, the LF antennae **116** detect the presence of the mobile communications device **150**, e.g., via intermittent signals transmitted by the LF antenna **134**.

At step **204**, an authentication process is performed between the vehicle **102** and the mobile communications device **150**. This may be implemented using standard Bluetooth authentication protocols. In an embodiment, a unique identifier may be programmed into the memory of the microcontroller **132** that identifies the vehicle **102**, such that the vehicle **102** receives the identifier from the mobile communications device **150** during the authentication process, and the vehicle **102** matches the identifier from the mobile communications device **150** to its own identifier.

At step **206**, the microcontroller **132** receives a response signal from the vehicle **102**, and the logic **138** determines whether the response indicates a successful authentication or whether the authentication process was unsuccessful.

Once successfully authenticated, the user selects an input component **137** associated with a PEPS function at step **208**, which is interpreted by the logic **138** at step **210**, and the microcontroller **132** transmits a corresponding signal to the vehicle **102** via the LF antennae **134** and **116**, respectively at step **212**. The CPU(s) **104** receives the signal, which is interpreted by the PEPS module **114**. The PEPS module **114** initiates the corresponding PEPS function with respect to the vehicle components **110** as described above.

The exemplary vehicle functions and communications have widespread applications. In one embodiment, a vehicle rental service may employ the vehicle functions and communications to enable quick and easy access to rental vehicles. For example, if the PEPS components **130** are built into a case or sleeve **160**, the unique identifier of the vehicle **102** can be programmed into the microcontroller **132**, which can then be presented to a rental customer for use on his/her mobile communications device. In this manner, the rental customer can activate PEPS features with his/her own mobile phone. The vehicle rental service no longer requires key fobs for each vehicle it services. In another embodiment of the vehicle rental service, the vehicle identifier can be transmitted over a network (e.g., cellular network) before the rental customer is present at the premises of the vehicle rental service location. In this example, the rental customer engages in a rental agreement over the phone or by computer web site, and the vehicle rental service electronically provides the vehicle identifier, vehicle make, and parking location of the vehicle. The rental customer can then bypass the process of checking in at a service counter and walk directly to the rental vehicle at the stated location. In addition, the logic **138** of the PEPS components **130** may be configured to revoke or suspend use of the vehicle functions and communications described herein in response to instructions received over the network **140** (e.g., from the vehicle rental service when the rental period is over or the customer notifies the vehicle rental service that his/her cellular telephone is lost).

With respect to the vehicle rental service application of the vehicle functions and communications, the vehicle rental service may also track information about the rental activities, such as routes taken and current location. In an embodiment, the location information may be transmitted through the mobile communications device **150** via the transceiver **129** over the network **140** to the vehicle rental service. The location information may be derived from data transmitted between the mobile communications device **150** and cellular towers in the vicinity of the vehicle **102**.

The location information derived from the mobile communications device **150** may also be used to match up with location information derived from a navigation device of the vehicle **102** in order to provide security and prevent communications derived from external sources (e.g., man-in-the-middle attacks).

In addition, authentication between a vehicle **102** and the mobile communications device **150** may be initiated using location information derived from the transceiver **129** that informs the vehicle **102** that the mobile communications device **150** is within range.

Technical effects of the vehicle functions and communications enable a user of a mobile communications device to implement various vehicle functions, such as authentication, passive entry passive start, wireless charging of the mobile communications device in the vehicle, and the tracking of location data. The mobile communications device is equipped with a peripheral device, such as a case or sleeve that has embedded circuitry for implementing the vehicle functions and communications described herein.

As described above, the invention may be embodied in the form of computer implemented processes and apparatuses for practicing those processes. Embodiments of the invention may also be embodied in the form of computer program code containing instructions embodied in tangible media, such as floppy diskettes, CD-ROMs, hard drives, or any other computer readable storage medium, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the invention. An embodiment of the invention can also be embodied in the form of computer program code, for example, whether stored in a storage medium, loaded into and/or executed by a computer, or transmitted over some transmission medium, such as over electrical wiring or cabling, through fiber optics, or via electromagnetic radiation, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the invention. When implemented on a general-purpose microprocessor, the computer program code segments configure the microprocessor to create specific logic circuits.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the application.

What is claimed is:

1. A system, comprising:

a case configured to receive a mobile communications device, wherein the case is embedded with circuitry

powered by a battery disposed in the mobile communications device, the circuitry configured to authenticate a vehicle and comprising:

a computer processor;

a low frequency antenna;

input components communicately coupled to the computer processor, and wherein the circuitry defines a wireless receiver that, in conjunction with a wireless charger of the vehicle, is configured to inductively charge the battery when the wireless receiver is in physical contact with the wireless charger; and

logic executable by the computer processor, the logic configured to implement a method, the method comprising:

authenticating the vehicle with the circuitry via wireless signals transmitted between the low frequency antenna and a low frequency antenna of the vehicle when the vehicle is in communicative range of the circuitry;

receiving a selection from one of the input components, the selection associated with a vehicle function; and

transmitting a request to implement the vehicle function via the low frequency antenna coupled to the computer processor and the low frequency antenna of the vehicle.

2. The system of claim **1**, wherein the vehicle function is a passive entry passive start function.

3. The system of claim **2**, wherein the passive entry passive start function is at least one of:

remote locking of a door;

remote unlocking of a door;

remote starting of vehicle engine;

remote activation of lights; and

remote activation of power windows.

4. The system of claim **1**, wherein the logic is further configured to implement programming a unique identifier to a memory of the computer processor, the unique identifier associated with the vehicle and the logic uses the unique identifier to authenticate the vehicle with the circuitry.

5. A method, comprising:

authenticating a vehicle with circuitry via wireless signals transmitted between a low frequency antenna of the circuitry and a low frequency antenna of the vehicle when the vehicle is in communicative range of the circuitry;

embedding the circuitry in a case that is configured to receive a mobile communications device;

communicatively coupling the case with the mobile communications device, via a coupling element, when the mobile communications device is placed in the case, the circuitry is powered by a battery disposed in the mobile communications device;

inductively charging the battery, via a wireless receiver embedded in the case in conjunction with a wireless charger of the vehicle, when the wireless receiver is in physical contact with the wireless charger;

receiving, via computer processor embedded in the circuitry, a selection from one of a plurality of input components embedded in the device, the selection associated with a vehicle function; and

transmitting a request to implement the vehicle function via the low frequency antenna coupled to the computer processor and the low frequency antenna of the vehicle.

6. The method of claim **5**, wherein the vehicle function is a passive entry passive start function.

7. The method of claim **6**, wherein the passive entry passive start function is at least one of:

remote locking of a door;

remote unlocking of a door;

remote starting of vehicle engine;

remote activation of lights; and

remote activation of power windows.

8. The method of claim **5**,

wherein the coupling element includes at least one of physical wiring and a wireless node.

9. The method of claim **5**, further comprising:

programming a unique identifier into a memory of the computer processor, wherein the unique identifier associated with the vehicle and the computer processor uses the unique identifier to authenticate the vehicle with the circuitry.

10. A computer program product comprising a storage medium embodied with computer instructions, which when executed by a computer processor embedded in circuitry, causes the computer processor to implement a method, the method comprising:

authenticating a vehicle with the circuitry via wireless signals transmitted between a low frequency antenna of the circuitry and a low frequency antenna of the vehicle when the vehicle is in communicative range of the circuitry;

embedding the circuitry in a case that is configured to receive a mobile communications device;

communicatively coupling the case with the mobile communications device, via a coupling element, when the mobile communications device is placed in the case, the circuitry is powered by a battery disposed in the mobile communications device;

inductively charging the battery, via a wireless receiver embedded in the case in conjunction with a wireless charger of the vehicle, when the wireless receiver is in physical contact with the wireless charger;

receiving a selection from one of a plurality of input components embedded in the circuitry, the selection associated with a vehicle function; and

transmitting a request to implement the vehicle function via the low frequency antenna coupled to the computer processor and the low frequency antenna of the vehicle.

11. The computer program product of claim **10**, wherein the vehicle function is a passive entry passive start function.

12. The computer program product of claim **11**, wherein the passive entry passive start function is at least one of:

remote locking of a door;

remote unlocking of a door;

remote starting of vehicle engine;

remote activation of lights; and

remote activation of power windows.

13. The computer program product of claim **10**,

wherein the coupling element includes at least one of physical wiring and a wireless node.

14. A system, comprising:

a case configured to receive a mobile communications device, wherein the case is embedded with circuitry powered by a battery disposed in the mobile communications device, the circuitry configured to authenticate a vehicle and comprising:

a computer processor;

a low frequency antenna;

input components communicately coupled to the computer processor; and

logic executable by the computer processor, the logic configured to implement a method, the method comprising:

authenticating the vehicle with the circuitry via wireless signals transmitted between the low frequency

antenna and a low frequency antenna of the vehicle when the vehicle is in communicative range of the circuitry;

receiving a selection from one of the input components, the selection associated with a vehicle function; and

transmitting a request to implement the vehicle function via the low frequency antenna coupled to the computer processor and the low frequency antenna of the vehicle.

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